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BERRY THINNING OF GRAPES

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INTRODUCTION

With the expansion in the production of table grapes in California, there has developed a demand for methods of improving the factors of quality and appearance—size of berry, brilliancy and uniformity of color, density[2] of cluster and sugar content. Much interest has been shown in the operation of berry thinning as a means of attaining some of the desired improvements. Although berry thinning has been practiced at sporadic intervals in California and as a regular operation in the production of table grapes for export in South Africa,[3] no exact figures concerning the responses of the vine to this operation have been found in viticultural literature.

The Division of Viticulture of the University of California has carried out an investigation for the purpose of obtaining definite information concerning the influence of berry thinning on (1) the size of berry, (2) the coloring of the fruit, and (3) the density of the clusters. In the course of this investigation tests of several methods of thinning were made.

The varieties Tokay and Malaga were used in all of the tests. In the case of the Tokay one plot of vines was located at the University Farm, Davis, and three plots in the Lodi section. Plots 1 and 2 of the vines near Lodi were in the Van Buskirk vineyards, plot 1 being just south of Acampo, and plot 2 about three miles southwest of Lodi. Plot 3 in the Lodi section was in the Hoffman vineyard three miles north of Victor. All of the Malaga vines were in the vineyards of the University Farm.

Definition of Berry Thinning.—Berry thinning is the operation of removing a certain proportion of the berries of each cluster.[4] It is done by cutting off the end of the main stem (rachis) and several branches of the cluster or by cutting off a sufficient part of the main

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[2] Density is used in this paper to indicate degree of compactness of cluster.

[3] Perold, A. I., A treatise on viticulture, p. 618–621. Macmillan Co., N. Y., 1927.

[4] No entire clusters are removed except when several clusters hang so close together as to interfere with one another or when the clusters are misshapen or so small that they will not develop into marketable fruit.

stem so as to retain only the desired number of berries. Berries are not removed singly. From 60 to 80 berries were left on a Tokay and 80 to 100 on a Malaga cluster. The number varied in accordance with the original size of the cluster.

THE INFLUENCE OF BERRY THINNING ON SIZE OF BERRY

To satisfy the table-grape markets of the United States the berries must be of good size. That berry thinning increases the size has been long known to some growers. There are, however, no published facts sufficiently definite and conclusive to serve as a basis for effective and economical procedure in vineyard operations. Growers naturally desire definite information concerning the possibilities before going forward with such an expensive operation as that of berry thinning.

The influence of berry thinning on size of berry is shown in table 1. Each of the figures represents three or more pickings for plots 1 and 2 and one or two pickings for plots 3 and 4. All of the berries of fifteen or more clusters were weighed at each picking.

TABLE 1

THE INFLUENCE OF BERRY THINNING ON SIZE OF BERRY AS INDICATED BY WEIGHT

Location of the plots	Weight of berry in ounces				Number of berries to a pound (1928)	
	1928		1929			
	Check plots	Berry-thinned plots	Check plots	Berry-thinned plots	Check plots	Berry-thinned plots
Tokay (Lodi section):						
Plot 1	.158	.198	.141	.172	100	80
Plot 2	.187	.217	.152	.177	85	73
Plot 3	.145	.175	.100	.124	110	91
Plot 4 (University Farm)	.141	.170	.120	.137	113	94
Malaga (University Farm)	.106	.130	.102	.128	151	123

Since there was considerable variation in size of berry both in the check and in the berry-thinned plots in Tokay at the different locations, the results for each location are given separately. This gives a better idea of the possibilities as well as the limitations of increasing size of berry by this operation than would the average results for the four locations. Equal increases cannot be expected under all conditions. The soil type, cultural handling, and so forth, may influence and limit the maximum size of berry that can be obtained.

The figures of table 1 indicate that the largest increase in size of Tokay berries in 1928 was 25 per cent (plot 1) while the smallest

increase was 16 per cent (plot 2). In plots 3 and 4 the increase was 21 per cent. The results of 1929 are in very close agreement with those of 1928. The increase in 1929 for plot 1 was 22 per cent, that for plot 2 was again 16 per cent, that for plot 3 was 24 per cent, and that for plot 4 was 14 per cent.

The increase in size of berry of the Malaga was 23 per cent in 1928 and 25 per cent in 1929.

The fact that the improvement in size of berry as a whole was virtually the same in both 1928 and 1929 although the growing seasons were very different adds support to the principle of berry thinning as a means of obtaining larger berries. The season of 1928 may be considered normal. On the contrary, that of 1929 was very abnormal. It opened with a late frost which destroyed many of the primary buds and shoots, thus delaying the early development, and forcing secondary shoots. The clusters on the shoots arising from secondary buds differed greatly in shape, from the normal clusters. The summer was below normal in temperature except for short periods when it was very warm. It would therefore appear that seasonal variations have little effect upon the influence of berry thinning on the per cent increase in size of berry.

The Influence of Time of Berry Thinning upon Size of Berry.— The figures of table 1 have to do with the average increases due to thinning at several dates on each lot or location each season. This is the average increase which might be expected in these varieties when the thinning extends over a period of 15 or 20 days. Thinning at different times during this period, however, does not affect the development of the berries to the same degree. The influence of time of berry thinning in 1928 is shown in table 2.

TABLE 2

The Influence of Time of Berry Thinning on the Size of Berry as Indicated by Weight in Ounces

Variety and location	Check	First thinning, 6/2/28	Second thinning, 6/11/28	Third thinning, 6/19/28
Tokay (Lodi section):				
Plot 1	.158±.011*	.223±.005	.187±.003	.180±.002
Plot 2	.187±.005	.238±.003	.201±.003	.198±.002
Plot 3	.145±.003	.180±.002	.170±.003	.156±.002
Plot 4 (University Farm)	.141±.003	.177±.002	.173±.002	.156±.002
Malaga (University Farm)	.106±.002	.143±.002	.117±.002	.113±.002

* In view of what appear to be small differences, the probable error, as calculated by Bessel's formula, is included in this table to give a better indication of the significance of the results.

The figures of table 2 show a definite correlation between time of berry thinning and increase in size of berry. For Tokay the thinnings of June 2 resulted in an increase of 32 per cent. The thinning of June 11 gave an increase of 18 per cent and that of June 19 an increase of 10 per cent. Although there are variations in the percentage increase for the several plots at the different thinnings, the trend of the influence of time of thinning is the same for all of the plots.

In 1929 an increase of 25 per cent was obtained by the June 12 and June 18 thinnings. In this season the thinning on June 26 resulted in an increase of 17 per cent and that on July 2 in an increase of only 11 per cent. Allowing for the fact that the blooming in 1929 was a week or ten days later than in 1928 the effects of thinning at the corresponding stages of the development of the berries in the two seasons are very similar. For example, the size of berry on June 12 in 1928 was about the same as it was on June 26 in 1929 and the increase in size of berry in 1928 was 18 per cent and that in 1929, 17 per cent. Again, for the last thinning in each season the development of berry was about the same and the increase in size of berry as a result of the thinning was 10 per cent in 1928 and 11 per cent in 1929. Owing to the frost in 1929, blooming was irregular, and hence the stage of development of the clusters was not uniform at the earliest berry thinnings. This lack of uniform development, no doubt, explains why the berries of the earliest thinning increased no more in size than those of the second. It might also account for the slightly smaller percentage increase in size of berry at the earliest thinning in this season than in 1928.

The response of Malaga to time of berry thinning, was very similar to that of the Tokay, the earliest thinning giving the largest increases in size of berry, and the latest thinning, the smallest.

Therefore, to obtain the largest increase in size by berry thinning, it should be done as soon as all of the berries have set. When delayed eight to ten days the gain was one-third less; and when delayed eighteen or twenty days, two-thirds less. This delayed thinning also increases sunburn by removing some of the bloom which is beginning to appear on the berries.

To berry-thin before the normal drop which follows blooming has occurred or before all of the berries that will develop have set, defeats the purpose of thinning. The thinning improves the nutrition of the retained berry "forms" to such an extent that many which would have dropped without the thinning develop into berries. This influence of berry thinning is illustrated in figure 1. In thinning these clusters, 50 per cent of the berries were removed. The cluster at the

left represents those thinned on June 2, after all the berries that would develop had set, whereas the cluster on the right represents those thinned on May 28 after full bloom but before all of the berries had set. Although 50 per cent of the berry forms on the cluster at the right were removed at thinning, it had only 4 per cent less berries at harvesting than the non-thinned clusters.

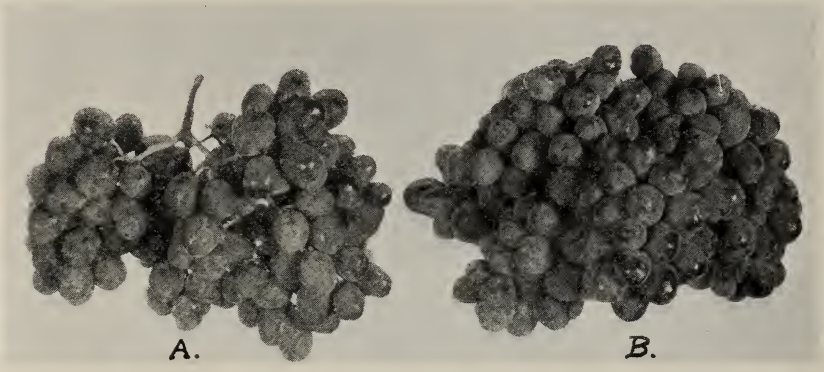

Fig. 1.—Showing the effect of too early berry thinning on compactness of cluster. *A*, berry-thinned after the drop following blooming had occurred. *B*, berry-thinned after full bloom but before the drop following blooming was complete.

THE INFLUENCE OF BERRY THINNING ON COLORING AND RIPENING

The importance of an attractively uniform and brilliant color has been very clear during recent seasons of overproduction. In the so-called white varieties it has become increasingly difficult to market grapes coming from localities in which the berries remain green in color although they are fairly large, firm, and of a suitable sugar content.

The Influence of Berry Thinning on Coloring.—The influence of berry thinning on coloring was measured by weighing the fruit removed at each of the several pickings. Since only fruit of a desirable color was removed, the amount of fruit harvested at each picking offers a basis for comparing the development of color of the fruit on the berry-thinned and check vines. The amounts of fruit harvested at the earlier pickings from plots 1 and 2 are shown in table 3.

The figures of table 3 show that five times as much fruit to a vine was harvested from the thinned vines as from the check vines at the first picking in 1928. The first and second pickings yielded more than twice as much fruit from the thinned as from the check vines. In

TABLE 3

THE INFLUENCE OF BERRY THINNING ON THE TIME OF COLORING OF TOKAY AS INDICATED BY THE AMOUNT OF FRUIT HARVESTED AT EACH PICKING

Location and year	Date of harvesting	Picking	Pounds of fruit to a vine harvested			
			Check	First thinning	Second thinning	Third thinning
1928 (Lodi):						
Plot 1	Sept. 18	First	0.6	11.8	11.7	7.6
	Sept. 29	Second	1.2	10.5	6.0	10.4
Plot 2	Sept. 12	First	2.9	12.7	13.9	19.5
	Sept. 22	Second	23.2	25.1	18.8	12.5
1929 (Lodi):						
Plot 1	Sept. 17	First	3.8	5.0	4.8	6.8
	Oct. 1	Second	18.6	20.8	20.0	18.0
	Oct. 9	Third	12.3	10.4	12.8	8.6
Plot 2	Sept. 20	Second	4.8	8.3	7.8	11.6
	Oct. 1	Third	9.9	14.4	11.9	12.6
	Oct. 9	Fourth	15.7	18.8	15.5	8.2

1929 a little less than twice as much fruit was taken from the thinned vines as from the check vines at the first picking. At the second picking one-third more fruit was removed from the thinned than from the check vines. As the season advanced, the amount of fruit removed from the thinned and unthinned vines was about equal. Late in the season more fruit was taken from the check than from the thinned vines. This was owing to the fact that there was still a considerable amount of fruit on the check vines as compared to the relatively small amount left on the thinned vines. The difference in coloring in favor of the thinned vines for the other plots was similar to that of plots 1 and 2.

In addition to developing earlier, the color of the thinned fruit was more uniform; that is, there was less difference in the shade or intensity of the color on the exposed side and the protected (shaded) side of the clusters. Thus, the quality and brilliancy as well as the quantity of color was improved.

The influence of berry thinning on coloring in the Malaga was not as marked as in the Tokay. There was a more uniform development of color. The improvement in color obtained with this variety at Davis, however, was not sufficient in itself to be of practical importance. In the University vineyard the Malaga is a very vigorous grower, and the fruit usually remains grass green in color. To obtain the desirable white to amber color under such conditions of growth is very difficult. Under more favorable conditions for the production of Malaga the influence of berry thinning on coloring is sufficient to

be worthy of consideration. In a semi-commercial experiment made by Dwight Long near Cutler, the improvement in the color of Malaga was almost as marked as for the Tokay in the Lodi section.

The time of berry thinning had little influence on the coloring of the fruit. In three of the four earliest pickings listed in table 3 slightly more fruit was removed from the vines of the third thinning than from the vines of the earlier thinnings. This difference was very small and it is what might be expected. Increase in size of berry and coloring seem to be competitive as regards certain substances that are produced in the vine; hence with a smaller increase in size of berry obtained by the late thinning, conditions are more favorable for coloring.

The Influence of Berry Thinning on Ripening.—It is a general observation among viticulturists that under given conditions the coloring of the fruit more or less parallels the accumulation of sugar. In view of the earlier coloring of the thinned fruit, it might be expected, therefore, that the berry thinning also hastens maturity. The influence of thinning on maturity is shown in table 4.

TABLE 4

The Influence of Berry Thinning on the Sugar Content of the Fruit; Data from Tokay Plots 1 and 2, Lodi

Year	Picking	Sugar content as degrees Balling			
		Check	First thinning	Second thinning	Third thinning
1928	First	17.3	21.4	22.0	22.1
	Second	20.7	22.2	22.7	23.0
1929	First	19.8	20.8	20.7	21.2
	Second	20.2	21.2	21.5	21.5

These figures indicate a definite earlier increase in the sugar of the thinned fruit. The increase in sugar, however, is relatively small and in the case of the Tokay it is not of as great commercial importance as the improvement in color. With other varieties and in early sections the hastening of ripening by thinning may be a factor worth considering in the production of early fruit.

The time of berry thinning had but very little influence on the increase in sugar. The fruit of the last thinning contained slightly more sugar. This difference in favor of the later thinning is not sufficient to be of importance.

THE INFLUENCE OF BERRY THINNING ON DENSITY OF CLUSTER

The general observation that the berry-thinned clusters are not so dense as the unthinned clusters has led to the unwarranted belief that the retained cluster parts, such as the cluster branches, grow longer following thinning. This would have the effect of giving each berry more room in which to develop, hence the mature berries although larger in size are not crowded together as closely as on the unthinned clusters.

To determine the correctness or fallacy of the above belief, measurements were made in 1928 on the length of the first branch of fifty clusters from the check vines and fifty clusters from the thinned vines taken from each of the stages of berry development indicated in table 5. Measurements were also made of the length of the pedicel on both thinned and unthinned vines. For the 1929 season the measurements on length of first branch of the clusters were repeated at two stages of berry development.

TABLE 5

LENGTH GROWTH MEASUREMENTS OF TOKAY AND MALAGA CLUSTER PARTS AFTER THE BLOOMING SEASON

Year	Measurements	Treatment of clusters	Mean length of parts, in inches			
			Just after full bloom	All berries set	Berries 1/3 grown	At harvesting
1928	Length of first branch of the cluster	Thinned	2.07	2.09	2.28	2.40
		Check	2.09	2.11	2.27	2.41
	Length of the pedicel (cap stem)	Thinned	.30	.36	.39	.39
		Check	.30	.35	.39	.39
1929	Length of the first branch of the cluster	Thinned		2.11		2.32
		Check		2.04		2.25

The first branch of the cluster increases slightly in length. This increase, however, is primarily the result of the increase in length of the pedicels. The increase in length was not influenced by berry thinning since it was the same in both the check and the thinned clusters. In the case of the pedicel the increase in length continues until the berries are about one-third grown. Its length at maturity is not influenced by berry thinning.

The improvement in the density of the cluster must, therefore, result from thinning out by removal of cluster parts in the region of the cluster that usually becomes too dense. In the Tokay and Malaga

this region extends from just above the middle to the apical end. It is shown in the ovals surrounding a part of the two Tokay clusters in figure 5. Thus, to be most effective in reducing density in these varieties, the method of thinning should remove the apical end and must thin or remove entirely the cluster parts in the mid-section of the cluster.

THE INFLUENCE OF BERRY THINNING ON THE WEIGHT OF CLUSTER AND THE NUMBER OF BERRIES TO A CLUSTER

The improvements in size of berry and coloring are in each case the direct result of a reduction in the number of berries to a cluster which has improved the nutrition of the retained berries. Density of cluster is improved, in the case of these varieties, by removing some of the cluster parts which give the retained berries sufficient space in which to develop without crowding.

The question now arises, is the reduction in the number of berries to a cluster, which is necessary to obtain the improvements in size of berry, coloring, and density, so great as to subtract from the attractiveness of the fruit as a result of reduction in size of cluster? A partial answer to this question is to be found in table 6 which gives the influence of thinning on the weight of cluster and the number of berries to a cluster.

TABLE 6

The Influence of Berry Thinning on Weight of Cluster and Number of Berries to a Cluster; Mean for the Three Plots Near Lodi

Year	Measurements	Check	First thinning	Second thinning	Third thinning
1928	Weight of cluster in pounds	1.01	0.73	0.74	0.69
	Per cent decrease in weight as a result of thinning		27.0	26.0	33.0
	Number of berries to a cluster	109	61	65	62
	Per cent decrease in the number of berries as a result of thinning		44	41	43
1929	Weight of cluster in pounds	.95	0.75	0.73	0.65
	Per cent decrease in weight as a result of thinning		21.0	23.0	31.0
	Number of berries to a cluster	101	73	71	66
	Per cent decrease in the number of berries as a result of thinning		28.0	30.0	35.0

The figures of table 6 show a reduction in weight of cluster as a result of thinning of from 27 to 33 per cent in 1928 and of from 21 to 31 per cent in 1929. In no case was the reduction in size of cluster sufficient to subtract from the quality of the fruit. The reduction in weight of cluster did not make packing more difficult. Actual tests

on packing showed that fruit of the thinned vines moved through the packing house somewhat faster than that of the check vines.

The reduction in the number of berries to a cluster ranged from 41 to 44 per cent for the three thinnings in 1928 and from 28 to 35 per cent for the three earliest thinnings in 1929. The smaller reduction in the number of berries to a cluster in 1929 was owing to the poorer set of berries on all clusters in that season.

The reduction in weight of cluster was in no case as great as the reduction in the number of berries to a cluster since the berries on the thinned clusters were larger than on those not thinned.

METHODS OF BERRY THINNING

The method of berry thinning must be adapted to the shape of cluster, the manner in which the berries set on the cluster parts, and the shape of cluster desired after thinning. Three methods were used in the experiments. They will be described and then the adaptations and limitations of each discussed.

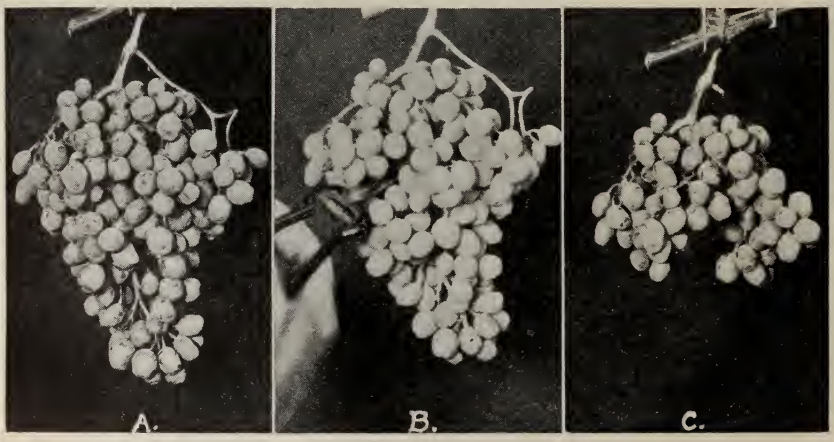

Fig. 2.—*A*, showing a cluster which is adapted to berry thinning by method 1. *B*, the shears placed for cutting the main stem of the cluster. *C*, the thinned cluster.

Method 1.—By this method three to five of the large branches at the base of the cluster are retained, the remaider of the cluster being removed with a single cut. A second cut is necessary to remove the modified tendril at the base of the cluster which usually has a few berries. The berries on this cluster part are always the slowest in maturing. The mature clusters thinned by this method are short and more or less globular. An unthinned cluster, the act of cutting the

main stem of a cluster, and a cluster thinned by this method are shown in figure 2, *A*, *B*, and *C*.

Since this method of thinning requires but two cuts it is simple and rapid. It requires a minimum amount of skill and care on the part of the person doing the thinning. The thinning can be done most readily with a grape trimming or picking shears having slightly curved blades.

Method 2.—In method 2 all of the branches along one side, except the uppermost branch of the main stem, are removed and the end of the cluster shortened back so as to retain the desired number of

Fig. 3.—*A*, showing a cluster which is adapted to berry thinning by methods 2 or 3. *B*, the act of thinning by method 2, using a knife. *C*, the same cluster after thinning.

berries (see figure 3, *A*, *B*, and *C*). Branches are retained on three sides of the main stem over its entire retained length and in most cases one branch at the base of the cluster on the fourth side. Between 30 and 40 per cent of the branches along the retained part of the main stem will usually be removed. It is assumed that as the berries enlarge on the retained branches of the cluster they will be crowded around the main stem so as to fill in the side from which the branches were removed. If the thinning is well done the clusters are approximately normal in shape.

The thinning by this method can be done most rapidly by means of a narrow-bladed knife, the end of which is turned to form a "hawk-bill." The use of a knife, however, requires skill and great care to

avoid injury to the main stem which might restrain or stop the development of the berries on the parts of the cluster beyond the injury. With any but very adept and careful workers it appears advisable to use trimming shears for the thinning.

Method 3.—In method 3 some of the branches in the region of the cluster which appear to be too dense, are removed from all sides of

Fig. 4.—Thinning by method 3. The positions at which cluster parts would be removed are indicated by curved marks.

the main stem and the end of the cluster shortened back so as to retain the desired number of berries. The thinning of a long, narrow Tokay cluster by this method is shown by the curved marks in figure 4. The number of branches removed will depend on their spacing along the main stem, on their size, and on the relative set of berries. Roughly, about the same number of branches will be removed with this method of thinning as with method 2. The normal shape of the cluster is retained.

With any but highly skilled workmen the thinning by this method must be done with trimming shears. Unskillful use of a narrow-bladed knife with a hook point usually results in injury to the retained branches. On the other hand, with highly skilled workmen the use of a knife facilitates the thinning.

The Influence of Method of Berry Thinning.—Along with the observations of the influence of method of thinning on shape of cluster and density of cluster, measurements were made of the weight of berry and of cluster and the number of berries were counted on a large number of clusters thinned by each method. These figures are recorded in table 7.

TABLE 7

The Influence of Method of Berry Thinning on Weight of Berry and Cluster and the Number of Berries to a Cluster

Year	Measurements	Method 1	Method 2	Method 3
1928	Weight of cluster in pounds	.76	.78	
	Weight of berry in ounces	.21	.21	
	Number of berries to a cluster	56.3	56.6	
1929	Weight of cluster in pounds	.71	.72	.70
	Weight of berry in ounces	.18	.18	.18
	Number of berries to a cluster	77.5	79.1	77.1

The figures of table 7 indicated that the method of berry thinning had no influence on the size (weight) of berry and weight of cluster. With the same reduction in the number of berries to a cluster with the different methods of thinning, the improvement in the nutrition of the retained berries should be equal; hence it might be expected that the influence on size of berries would be the same. This is exactly what has happened. There also was no influence of the method of thinning on coloring.

Which Method of Thinning Should be Used?—In choosing the method of berry thinning to be used, the shape of cluster and the tendency of the cluster to become too dense must be given prime consideration. In the Tokay and Malaga the normal-shaped cluster tends to be heavy and relatively short. The branches at the base of the cluster are usually rather large and as indicated in the Tokay cluster of figure 5, *A*, these branches usually do not set so many berries as to become too dense. Also as shown in figure 5, *A* and *B*, the region extending from below the middle to the apical end of the cluster tends to be the densest part. Cluster shape, however, varies on one and the same vine within a season, and between seasons, so that the shape shown in figure 5, *A*, although it is the usual shape, is not

exclusive. In 1929 a late frost destroyed most of the primary buds. The crop of clusters on the shoots arising from secondary buds on Tokay were of the shape shown in figure 5, *B*. Furthermore, it is necessary to consider the reaction of the buying public to the shape of cluster at maturity since the method of thinning very materially influences the shape of the mature cluster. The cost and feasibility of the method of thinning with the workmen available also is of importance.

Fig. 5.—*A*, showing a Tokay cluster of normal shape. *B*, a long narrow Tokay cluster. The oval encircles that part of Tokay and Malaga clusters which tends to become too dense.

With clusters of the shape indicated in figure 5, *A*, and with no discriminating against a short, heavy, or globular cluster by the buying public, method 1 should prove to be most satisfactory as well as most economical. On the contrary, with long clusters that have relatively short branches at the base, such as that shown in figure 5, *B*, method 1 cannot be used. If the branches at the base of the cluster are short, it is necessary to leave as many as six to eight in order to retain the desired number of berries. Such clusters usually become very dense at the apical end. When only three to five of the

branches are retained, they have sufficient space in which to spread, hence they do not become crowded. This, however, is not true when as many as six to eight branches are retained.

Method 2 should give equally satisfactory results with clusters of the shapes shown in figure 5, *A* and *B*. There may be some objection to this method since the side of the main stem from which the branches are removed at thinning may remain partially bare when the thinning has been too severe. If this side of the cluster remains bare, the main stem bends in that direction owing to the weight of the berries on the other side.

Although this method of thinning costs approximately twice as much as method 1 it is only about one-half as costly as method 3. This being the case, it is worthy of trial on clusters which are narrow and long, even though the shape of the mature clusters may not be as perfect as when thinned by method 3.

Method 3 is especially adapted to long narrow clusters having many short branches. It is perfectly suited to clusters such as that shown in figure 5, *B*. This method has the advantage over method 2 in that the mature clusters are of the same shape as before thinning, except that they are shorter. When carefully done, perfect results are obtained with practically all shapes of clusters of the Tokay and Malaga. Cost is the limiting factor in its use. It costs approximately four times as much as method 1 and twice as much as method 2, if the thinning in the case of method 2 can be done with a knife.

Some varieties produce clusters of which the basal branches tend to become too dense. None of the above methods of thinning is adequate for clusters of this type. The density of the basal branches can be reduced by removing small sub-branches from the under side by means of a trimming shears. In the case of very large branches the end should be also cut off. The cost of berry thinning varieties which regularly produce clusters of this type will be high.

PRUNING FOR BERRY THINNING

Since berry thinning reduces the weight of cluster, the crop to a thinned vine will not be as large as that with unthinned clusters when the pruning is the same. To make up for the loss in crop occasioned by berry thinning, more buds should be retained at the time of pruning. The reduction in weight of cluster as a result of the thinning has been about 30 per cent, hence instead of leaving spurs with two and three buds, which is the general practice with Tokay,

spurs of three to five buds should be retained. It is assumed that the same number of spurs will be retained and the number of buds—three to five—will be left in accordance with the size or capacity of the cane of which the retained spur is the basal portion.

To increase the length of the spurs from two or three buds to three to five buds, will, no doubt, increase the number of clusters to a vine more than 30 per cent, which has been the approximate reduction in weight of cluster as a result of thinning. A greater increase is desirable since this will allow for the removal of some good clusters where they happen to be overcrowded and of even greater importance it allows for the removal of misshapen and small clusters; thus, all of the energy of the vine is directed toward the nourishment of clusters which are potentially marketable. In addition to this the increase in the length of the spurs spreads the fruit over a larger area which permits each cluster of a large crop to hang free. This condition in itself fosters a better development of the cluster and berries and a more uniform coloring of the fruit. The retention of more wood also increases the capacity of the vine for production.

The grower must be cautioned against an increase in the number of buds at pruning as indicated above unless he is prepared to thin. Increasing the amount of wood at pruning without following it up with thinning to control the crop can only result in poor quality fruit. The berries will be smaller, the coloring poorer, and the sugar content lower. With longer spurs it is also more difficult to maintain the shape of the vine and special care should be given to the selection of the spurs and the use of renewal spurs so that the arms can be shortened back when they become too long.

THE COST OF BERRY THINNING

Berry thinning of Tokay and Malaga will cost from five to thirty dollars per acre according to the age and shape of the vines, the number of clusters that are thinned, the method of thinning employed, and the type of workmen available. Under usual conditions with vines of average size and good shape, the cost of thinning with method 1 should range from five to ten dollars per acre; that of method 2, if done with a knife, from eight to twenty dollars, and if done with shears from ten to twenty-five dollars per acre; and that of method 3 from fifteen to thirty dollars per acre.

PROBABLE RETURNS FROM BERRY THINNING

Although the principal increase in returns to be expected from berry thinning is that which results from improvement in the quality of the fruit, other effects of berry thinning which tend to increase returns have come to light in the course of these tests.

Berry Thinning Facilitates Harvesting.—During the harvesting of the Tokay, records were kept of the amount of fruit picked by each picker in a given time from the check vines and the vines of the different thinnings. In order to equalize the different rates at which the several men worked, all of the pickers worked on the same lot of fruit until it was harvested and then moved to the next. The rate at which the fruit was harvested from the check and the thinned vines is shown in table 8.

TABLE 8

The Influence of Berry Thinning on the Rate of Harvesting the Fruit

Year	Location	Picking	Pounds of fruit harvested per hour per man	
			Check vines	Thinned vines
1928	Plot 1	First	108	168
		Second	270	342
	Plot 2	First	54	222
		Second	60	216
	Plot 3	First	60	126
1929	Plot 1	First	84	118
		Second	165	191
	Plot 2	First	105	151
		Second	148	188

These figures show a rather marked increase in the rate at which the thinned fruit was harvested; the increase ranging from 22 per cent faster to several times as fast. In this case the smallest percentage increase in the rate of harvesting is sufficient to make a material saving in picking costs. The figures of table 8 are substantiated by the experience of several growers of Tokay who have berry-thinned on an extensive scale. Their experience indicates that a considerable part or the whole cost of thinning is regained as a result of the lower cost at which the fruit of the thinned vines can be harvested. No data are at hand to indicate the effect of berry thinning on the cost of harvesting other varieties.

In the Tokay, berry thinning facilitates harvesting primarily through its effect on coloring. The thinned clusters color more uniformly. With uniformly colored berries on all sides of the clusters it is only necessary for the picker to look at one side of a cluster to see if it is ready for harvesting. On the contrary, with the unthinned fruit, especially in some sections, the fruit on the exposed and on the protected sides of the clusters does not color at the same rate; hence it is necessary for the picker to look at both of these sides of a cluster before he can be sure it is ready for harvesting.

Berry Thinning May Facilitate Packing.—In 1928 one lot of fruit of the thinned and another of the check vines was followed through the packing house. The figures obtained on the number of packages of fruit packed per hour per packer show that the thinned fruit was placed in the containers somewhat faster than the unthinned fruit. Instead of putting up 7 packages per hour, which was the rate of packing for the unthinned fruit, the same packers put up 7.7 packages of the thinned fruit. The clusters of the thinned fruit were of a more convenient size and less dense than those of the unthinned fruit, which facilitated placing them in the containers. In addition to its being more convenient for packing, the thinned fruit required less trimming than the check fruit. The culls in the check fruit amounted to 13.9 per cent while in the thinned fruit only 9.9 per cent was rejected.

Berry Thinning Improves the Quality of the Fruit.—The most important value of berry thinning is its improvement of the quality of the fruit. The improvement results primarily from an increase in size of berry, a better development of color, and a less compact cluster. To evalute, in dollars and cents, the improvement in quality is difficult. The care and exactness with which the work of thinning is done varies widely as does the need of berry thinning in different localities and in different varieties. Again, it is difficult to obtain the necessary quantity of data to enable one to arrive at a definite value of the operation even if one would ignore the variations just mentioned. The improvement in quality also may not always cause the grapes to bring a higher price, for, as was the case at times during 1929, the poor fruit fixed the price rather than the good fruit.

Some information, however, has been collected during the past two seasons for Tokay which seems to indicate that the average benefit derived from berry thinning varies from 10 to 20 cents a package. With careful work in a section where the Tokay is in need of berry thinning, the benefit may be considerably larger than the above. On the other hand, with careless or misdirected work or with the Tokay

in a section where the berries are normally large, the fruit well colored, and the cluster just well filled, berry thinning can be of no benefit; in fact, it may even reduce the selling price of the fruit. Also, with a variety like Tokay in a section where the summer temperature is sufficiently high to prevent coloring, it is useless to berry thin with the hope of obtaining well colored fruit.

SUMMARY

Berry thinning increased the size of Tokay and Malaga berries from 10 to 30 per cent. There was a definite correlation between increase in size of berry and the time of berry thinning. Maximum increase was obtained by thinning as soon as the normal drop following blooming was complete.

Berry thinning improved the coloring of the Tokay. The improvement was primarily a more uniform development of the color on the thinned fruit.

The berry-thinned fruit ripened somewhat in advance of the unthinned fruit.

The clusters of the berry-thinned fruit were not so dense as those of the unthinned fruit. Since the cluster parts, except the pedicels, do not elongate after the berries have set, the improvement in density results from the removal of the cluster parts in the region of the cluster that tends to become too dense. The Tokay and Malaga clusters may be too dense in the region extending from just below the middle to the apical end.

The berry-thinned clusters were not as heavy as the unthinned clusters. Although the percentage reduction in the number of berries ranged from 30 to 45 per cent, the reduction in weight of cluster was only 20 to 30 per cent. The smaller reduction in weight of cluster is accounted for by the increase in size of berry on the thinned clusters.

Three methods of berry thinning were tested. The adaptations and limitations of each method are indicated.

The method of thinning, where the degree of thinning was the same, has no influence on increase in size of berry, coloring of the fruit, or weight of the clusters.

Since berry thinning reduces the weight of clusters from 20 to 30 per cent, provision must be made at the time of pruning for a sufficient increase in the number of clusters to produce a normal crop.

The cost of berry thinning is influenced by the age and shape of the vines, the number of clusters that require thinning, and the

method of thinning employed and the quality of the workmen available. Under usual conditions the cost with method 1 will range from five to ten dollars per acre; that of method 2, if a knife is used, from eight to twenty dollars, and when a shear is used, from ten to twenty-five dollars per acre; and that of method 3 from fifteen to thirty dollars per acre.

The remuneration for berry thinning results from reduced costs of harvesting, reduced costs of packing, and increased returns from the improvement in the quality of appearance of the fruit.

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